A COMPUTER-BASED SOIL EVALUATION SYSTEM FOR ASSESSING SOIL PRODUCTIVITY

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SUMMARY

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This article, discussion of earlier papers, summarizes the various stages of a recently developed Computer-Based Soil Evaluation System (COBASES) for Sevilla soils. The system employs soil and crop yield information from a representative area, calibrating multiple regression models as transfer functions of soil productivity. Optimization and application of the models to other analogue areas are evenly described.

Field variability of crop production is a consequence of the variability in plant genetic properties in adition to environmental factors. For a given crop grown during a specific season in a certain area, and under the same climate and management level, spatial variability in yield is determined mainly by soil variability. These both variabilities are analyzed and quantified by soil evaluation according to its agricultural productivity. Presently with available computer techniques for storing and retrieving information, it is possible to prepare both more and better estimates of expectable yields from soils.

The purpose of the Computer-Based Soil Evaluation System (COBASES) was to predict potential soil productivity for certain crops, based on selected soil properties. Figure 1 shows a generalized diagram of the system developed and used in soils of Sevilla, Spain.

BASIC INFORMATION

Basic information referred to soil and crop yield was recorded from sites having similar environmental conditions within a representative area. This test area is located on the Guadalquivir Valley in the Province of Sevilla, and has the general characteristics of a Mediterranean climate. A detailed soil survey in the area supplied the soil data. The selected soils were classified in the

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following great groups: Haploxeralfs, Rhodoxeralfs, Xerofluvents and Chromoxererts, as described in «Soil Taxonomy» (Soil Survey Staff, 1975). Soil properties required for the evaluation system were: useful depth, clay content, depth to hydromorphic features, carbonate content, salinity, sodium saturation and cation exchange capacity. A control section of the soil profile was defined for taking soil samples for chemical determinations.

Information on yields of wheat, field corn and cotton for the soils selected was provided by farmers, soil scientists and agronomists. Estimated average yields were based on actual records so as correspond to production obtained in recent years (1976 and previous) under a high level of management (De la Rosa et al., 1981 a).

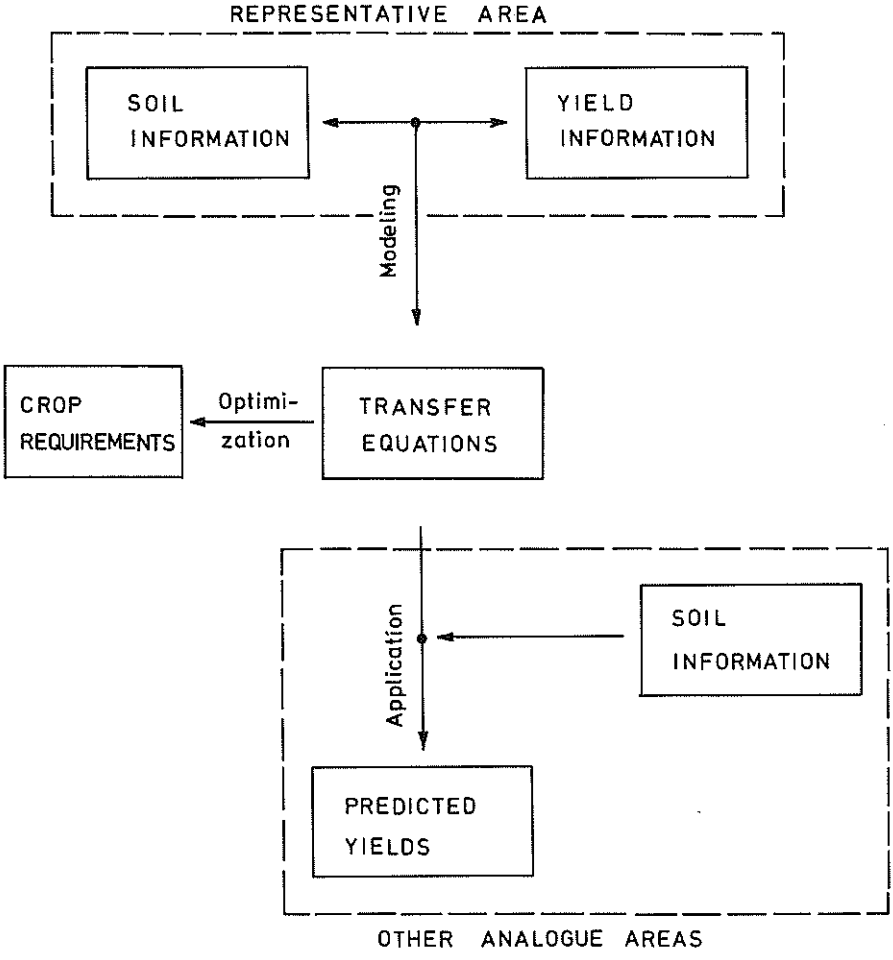

FIG. 1. Generalized diagram of the Computer-Based Soil Evaluation System (COBASES) for assessing soil productivity.

Data analysis

Statistical modeling was followed to formulate the relationships between soil parameters and yield information. In this analysis, as a particular case of multiple regression (Cooley and Lohnes, 1971), the independent variables were known as soil properties, and the dependent variable was referred to as predicted yield, for each crop. The three versions of COBASES (wheat, corn and cotton) were calibrated using the «Biomedical Computer Programs, BMDP» (Dixon, 1975) on an Univac 1108 computer at the Centro de Cálculo, Universidad de Sevilla. It is interesting to note that other mathematical procedures, such as stochastic modeling, could be applicable to the system to explain the spatial variability of crop yield.

The results of calibration and validation analyses indicated that the computerized statistical models could be used to predict the relative productivity of the selected soils. The independent variables considered and their interactions accounted for a great part of the variation in wheat, corn and cotton yields (De la Rosa et al., 1981 a).

Application

By application of the computerized transfer equations: polynomial regression models for the three crops, developed with information of the representative area, it was calculated the predicting yields in benchmark soils of analogue areas from Sevilla Province (De la Rosa et al., 1982). These authors reported previously the soil characterization of the benchmark soils, including the characteristics which are independent variables in the models. The application of COBASE allowed a reasonably good predictions of crop yield from inputs of soil parameters.

The system may be equally useful to transfer productivity information to other agricultural areas. Also, COBASES could be used as subsystem of possible soil-plant-atmospheric system for predicting crop yields of land units.

Optimization

On the basis of the polynomial regression models, a mathematical procedure was followed in order to find a combination of independent variables to maximize predicted yields (De la Rosa and Almorza, 1980). The procedure, described by Rey-Pastor (1967), was: simplification of the function analysis using natural restrictions for the independent variables; and then, by taking the first derivate with respect to each soil parameter, setting it equal to zero and solving a system of simultaneous equations. The results: combinations of level of soil properties mathematically calculated, could be considered as optimum levels or crop requirements for maximum wheat, corn and cotton yields in the region.

LAST REMARKS

The inclusion of Landsat data, as a new information source, to COBASES is now under development by the author and collaborators. Land cover data derived from digital image processing of Landsat spectral data will be used to improve the models. It appears possible that differences in soil productivity can be also quantified on this input. Thus, in areas where no soil characterization exists, Landsat information would be used to derive a lower approximation to predicted yields.

Finally, it would be necessary to note that the system (COBASES) is part of a soil information base (BID-CEBAC). The initial data included in the base are morphological, physical, chemical, engineering and site information for selected Sevilla soils. This data base performs not only mathematical analysis, but also file management as data selection, recording and transformation. The processed information can be obtained in various forms by previously developed computer programs (e. g.: De la Rosa et al., 1981 b).

RESUMEN

En el presente trabajo, que responde a la discusión de otros trabajos del autor y colaboradores, se realiza un resumen de las diversas etapas de desarrollo y aplicación del sistema computerizado de evaluación de suelos COBASES. Este sistema utiliza información edafológica y de producción de ciertos cultivos que procede de un área representativa de la provincia de Sevilla. La manipulación matemática computacional de la información, permite formular y calibrar modelos estadísticos de regresión. Los modelos se aplican a suelos representativos de otras áreas de la provincia, con objeto de extrapolar la información agronómica de partida.

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